ELECTROMAGNETIC PROPERTIES OF PORTLAND CEMENT CONCRETE USING MICROWAVE NONDESTRUCTIVE TESTING TECHNIQUES

By

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Thesis is submitted in fulfillment
of the requirements for the degree of
Master of Science in Civil Engineering

UNIVERSITI TEKNOLOGI MARA
MAY 2000

DEDICATION

TO MY PARENTS
MOHD & MARIAM

TO MY WIFE
SITI HAFSAH

ACKNOWLEDGEMENTS

I would like to thank my supervisors Professor Dr. Ir. Wan Mahmood B. Wan A. Majid and Associated Professor Dr. Deepak Kumar Ghodgaonkar for their support and encouragement during the duration of my study. This work would not have been possible without their guidance and input. Also I would like to thank the post graduate committee in the faculty of civil engineering, Universiti Teknologi MARA, Assoc. Prof. Dr. Mohd Salleh Mohd Noh and Dr. Mohd Yusuf for their advice and assistance during the completion of this work.

My sincere and special thanks to The examiners of this thesis Prof. Dr. L. F. Boswell, Director, Ocean Engineering Research Center, City University, London, UK, and Assoc. Prof. Dr. Khafilah Din, Universiti Teknologi MARA, Malaysia for their advices and comments during the completion of this work.

My sincere and special thanks to all lecturers and staff of microwave lab, Faculty of Electrical Engineering, UiTM for their support and providing access to the required materials and instruments for the completion of this study. Also special thanks for staffs of the concrete lab, Faculty of Civil Engineering, UiTM for their support and help during the study.

Finally I would like to express my deepest thank to my family, especially my parents (Mohd & Mariam) and my wife Siti Hafsah for their understanding, support and encouragement during the study.

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ABSTRACT

The use of electromagnetic waves as a nondestructive evaluation technique to evaluate Portland cement concrete (PCC) structures is based on the principle that the change in structure, composition, condition, or basic properties of PCC results in a change in its electromagnetic properties. The near field open-ended rectangular waveguide is one of the few devices that can make accurate measurements of the electromagnetic properties of PCC in the frequency range of 7.0 GHz to 13.0 GHz. A microwave measurement system using open-ended rectangular waveguide developed at Universiti Teknologi MARA was used to measure the electromagnetic properties of PCC. Also, a study was conducted to investigate the effect of the basic properties and conditions of PCC, namely, curing time, water cement ratio (w/c), moisture content, curing type, compressive strength, cement type, cement content, aggregate type, aggregate ratio and maximum aggregate size on the electromagnetic properties of PCC.

Measurements were conducted in the frequency domain. The research found that, the electromagnetic properties decrease with increasing curing age. The electromagnetic properties of PCC with lower w/c ratio is lower than the PCC with higher w/c ratio at early age of curing, this is reversed after hydration (curing) is completed. The electromagnetic properties of PCC increase with increasing moisture content. There is a significant difference in the electromagnetic properties of PCC cured using different type of curing methods such as, submerged in water, cover by wet cotton and cured in air and ambient humidity. The microwave nondestructive testing using near field open-ended rectangular waveguide can be used for determination of w/c ratio, compressive strength and moisture content from the measurement of reflection coefficients, dielectric constants, loss factors and conductivity. There is no significant difference between the electromagnetic properties of PCC mixes using different type of Portland cement (Type I and Type II). Mixes containing limestone aggregate had a lower reflection coefficient than those containing granite. Also, mixes containing limestone had a greater dielectric constant and loss factor than those containing granite.